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THE BOTANICAL GAZETTE

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CONTENTS:

A study of some anatomical characters of North American Gramineæ. III. (With plates XXIII—XXIV.)—*Theo. Holm* 275
On the structure and dimorphism of Hypocrea tuberiformis. (With plate XXV.)—*Geo. F. Atkinson* 282
Notes on the flora of Canada.—*James M. Macoun* 285
What the station botanists are doing.—*Byron D. Halsted* 288
BRIEFER ARTICLES 292
A neglected Spartina: *Geo. Vasey*.
EDITORIAL 293
Ignorance of plant physiology.
CURRENT LITERATURE 293
Recent systematic papers.—Minor Notices.
OPEN LETTERS 296
Where is the home of Calypso?—Botanical clubs in California.
NOTES AND NEWS 297
Personals.—British Mycetozoa.—Parry Herbarium. — Smoke killing shade trees.— Sphærotheca lanestris.— Phanerogamous parasites.—Botanical club of Canada.—Laticiferous tissue.

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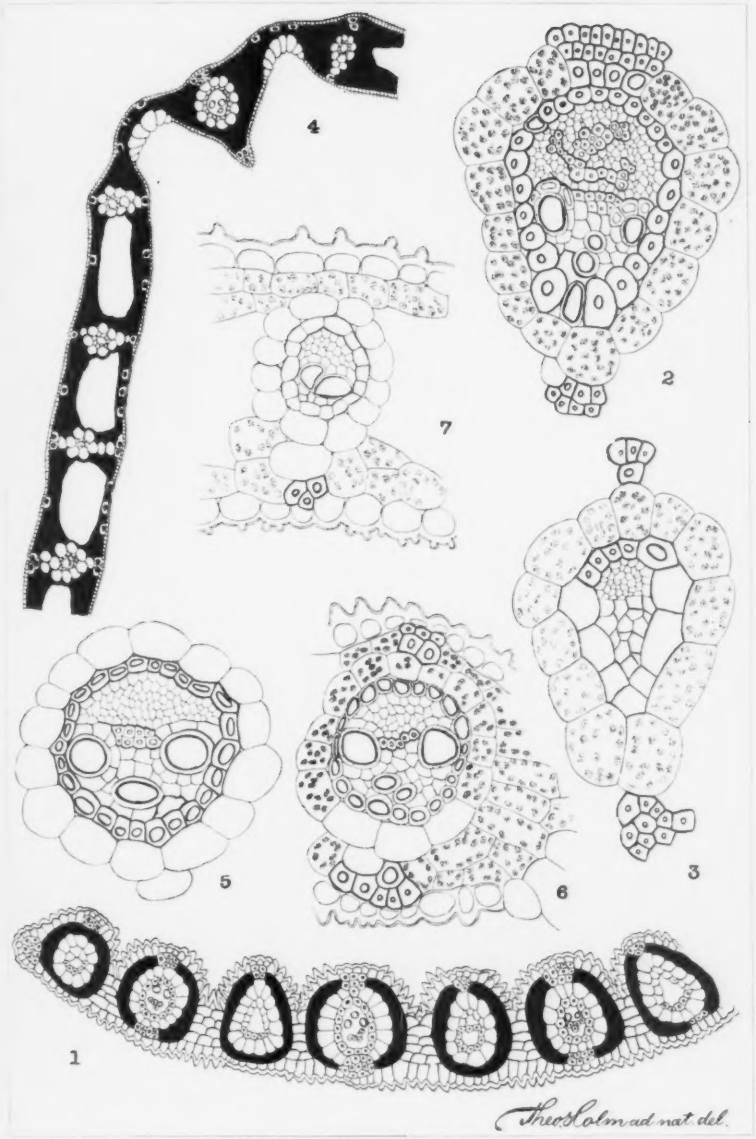

HOLM on DISTICHLIS and PLEUROPOGON.

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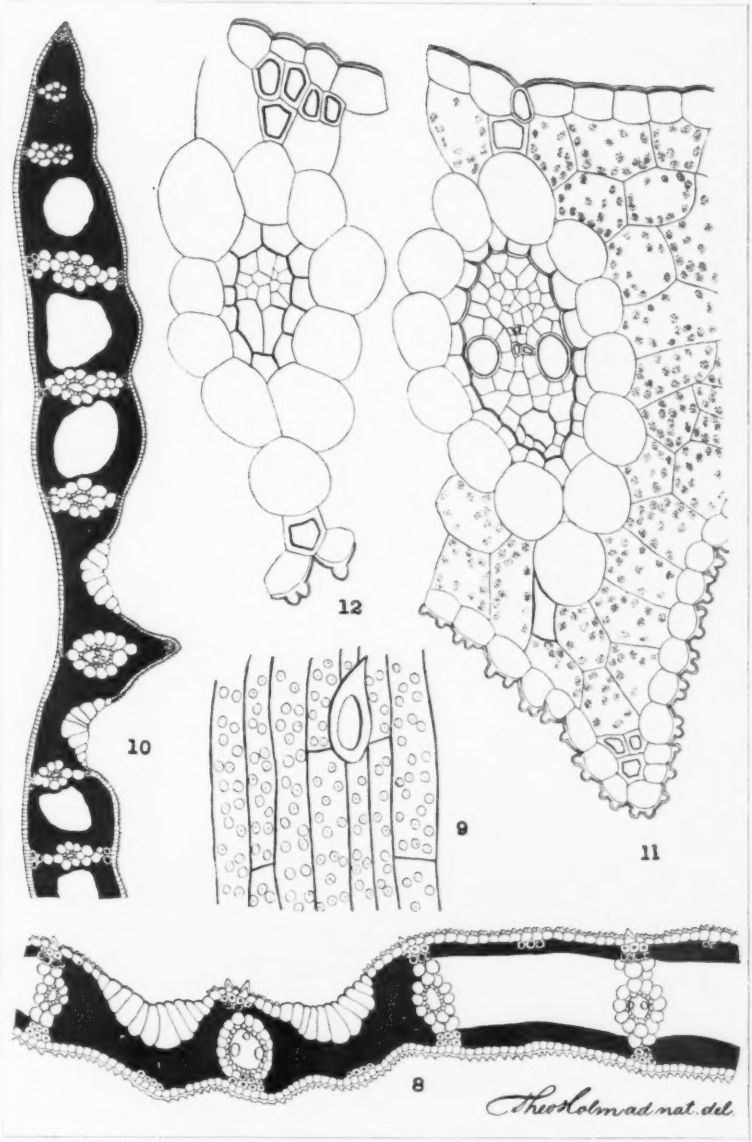


HOLM on DISTICHLIS and PLEUROPOGON.

VOL. XVI. NO. 10.—BOTANICAL GAZETTE.—OCT., 1891.

A study of some anatomical characters of North American Gramineæ. III.

THEO. HOLM.

Distichlis and Pleuropogon.

(WITH PLATES XXIII AND XXIV.)

Distichlis maritima Rafinesque. — While engaged in studying the leaf-structure of *Uniola Palmeri* Vasey, I was well aware of the great similarity that exists between this species and the genus Distichlis in external characters of the inflorescence, the rhizome, and the rigid, densely 2-ranked, involute leaves. Now having examined the anatomy of the leaf of a number of specimens of Distichlis, the similarity between these two plants has been found to be so striking that it seems most natural to consider Uniola Palmeri as a true Distichlis. Professor F. Lamson-Scribner has also informed me that on seeing the plant, he immediately took it for a Distichlis and was unable to distinguish it from this genus.

In studying the leaf-structure of Distichlis maritima, several male and female individuals have been examined from different parts of North America, and although the structure is essentially the same, a few differences have been observed. If we take the entire structure of the leaf into consideration and compare it with that of the so-called Uniola Palmeri, described in the preceding paper, it will be difficult to find any essential difference. We may take for comparison the leaf of a female plant of D. maritima from western Texas of which a transverse section is figured on plate XXIII, fig. 1.

The epidermis of both faces shows the same structure as described for the superior face of Uniola Palmeri, having numerous warts and rather pointed epidermal expansions. The structure of the mestome-bundles is exactly the same and the development of these as well as their distribution accords perfectly with what we have seen in U. Palmeri, viz.: a thin-walled and green proper parenchyma-sheath, surrounding, at least in the largest bundles, a closed ring of very thick-walled parenchyma. Furthermore the leptome and hadrome are often separated by a layer of similar parenchyma, and

groups of very thick-walled leptome-parenchyma are also observable in the strongest bundles. The stereome, the mesophyll and the uncolored parenchyma agree entirely with that of U. Palmeri. The leaf structure of a series of specimens of D. maritima, male and female, but from widely separated localities is here compared:

Arizona, ♀: The stereome is rather weakly developed and the blade is relatively broader.—California, ♀: Agrees in all details with the specimen from western Texas, described above.—New Jersey, ♀: Especially characterized by the very rough inferior face of the leaf, due to numerous warts. The stereome is very strongly developed above and below the mestome-bundles.—Montana, ♀: Differs from all the above mentioned female plants in having a closed ring of merely thin-walled parenchyma inside the proper sheath, and no thick-walled parenchyma either in the leptome or between this and the hadrome. The superior epidermis shows very long thorn-shaped and curved expansions.—Arizona, ♀: The superior epidermis shows short, thorn-shaped expansions, and long hairs, especially towards the base of the blade, situated among the bulliform cells. The inferior epidermis is on the contrary nearly smooth and without any hairs. The mestome-bundles show the same structure as described above for the female specimen, and the groups of stereome are strongly marked.—Washington, ♀: Both faces of the leaf are very rough, and the stereome shows an exceedingly strong development. There is a closed ring of very thick-walled parenchyma inside the proper sheath of the largest mestome-bundles, and the leptome is nearly divided into two separate groups by similar cells.—Vancouver Island, ♀: This specimen is well characterized from the preceding in having merely a horse-shoe-shaped layer of thick-walled parenchyma on the leptome side.—Montana, ♂ (alkaline soil): This specimen, compared with that described above from the same locality, but not from the same kind of soil, shows a remarkable difference in having a layer of very thick-walled parenchyma inside the proper sheath. Groups of similar cells are scattered in the leptome and a layer separating it from the hadrome. The superior epidermis has warts, but no long thorns, and the inferior one is nearly smooth with only a few projecting warts.

D. maritima Raf., var. *stricta*, ♂ from Nebraska: This form is especially characterized anatomically by the hairy and

rough epidermis of the superior face of the blade, where numerous thorn-shaped expansions are intermixed with conical warts. The stereome is rather strongly developed, while the mestome-bundles, the mesophyll, etc., agree with what has been mentioned above for the typical form.

D. maritima Raf., var. *laxa*, ♀ from Utah: The epidermis of the leaf is nearly smooth on both faces, being destitute of hairs and thorn-shaped expansions; otherwise it agrees perfectly with the preceding variety.

D. thalassica Humb. et Kth., ♂ from Lower California: The leaf of this species shows the same structure in most details as the preceding D. maritima. It is, however, quite well characterized by the very rough epidermis, of which that of the superior face shows several sharp-pointed expansions, while that of the inferior face has numerous conical warts. The largest mestome-bundles have a closed ring of thick-walled parenchyma inside the proper sheath, and the leptome contains groups of similar cells, by which it is also separated from the hadrome. The stereome represents groups of considerable size above and below the largest mestome-bundles, but is entirely wanting below the smallest ones.

D. prostrata Benth., ♂ from Mexico: The leaves are rough above, hairy below and along the margins; the epidermal expansions of the superior face are thorn-shaped, while those of the inferior are merely warts or soft hairs. The mestome-parenchyma does not show such thick-walled cells as described for the preceding species, and the leptome is but imperfectly separated from the hadrome. As to the stereome, this forms merely small groups above and below the strongest mestome-bundles, and the uncolored parenchyma is only represented by small groups between the bulliform cells and the inferior epidermis. Considered altogether the anatomical structure of the leaf in the genus Distichlis is very uniform, and it does not seem possible to give any special characters, by which either the varieties or the supposed species thalassica and prostrata may be distinguished from the species maritima; because we have seen that male and female specimens of this last show variations among themselves nearly equivalent with the differences in the two varieties and subspecies.

Of the genus *Pleuropogon*, which is closely related to Uniola and Distichlis, three species are known. Two of these, *P. refractum* Gr. and *P. Californicum* (Nees), are inhabitants of

California, while the third one, *P. Sabinei* R. Brown, is a high arctic type. Specimens of this were collected at Cape York in northwestern Greenland by the Swedish paleontologist Nathorst, who has kindly furnished me with several finely preserved individuals.

The leaf structure shows in these species a rather uniform aspect, which strikingly indicates their occurrence in wet meadows, although they live under such widely different climatological conditions. Very characteristic are the large lacunes in the mesophyll, the merely two groups of bulliform-cells in the carene, and the proportionally weak development of the stereome.

Pleuropogon refractum Gr.—The epidermis cells are rectangular with nearly straight and rather thin walls and there are on both faces of the leaf numerous conical warts. The superior face shows also several thick-walled and sharp-pointed expansions, which are directed upwards and which form long lines above the stereome-bundles (plate XXIV, fig. 9). Stomates are present on both faces of the leaf and are partly surmounted by conical warts. The bulliform cells form two groups, one at each side of the midrib; they are large and their exterior walls are entirely smooth in contrast to the other cells of the epidermis (plate XXIV, fig. 8).

The mestome-bundles represent two degrees of development; the median one (plate XXIII, fig. 6) is the largest in the whole blade and forms a slightly prominent carene. It is surrounded by a thin-walled parenchyma-sheath of which a part contains chlorophyll. Inside this, the proper sheath, is also to be observed a true mestome-sheath, the cells of which are somewhat thickened. The leptome is separated from the hadrome by a single stratum of thick-walled mestome-parenchyma, and there is a small group of stereome above and below the entire bundle. As to the corresponding mestome-bundles in the lateral parts of the blade, these differ from the median one merely by having a few cells of uncolored parenchyma on both faces, so that the stereome is not here in contact with the parenchyma-sheath. A small mestome-bundle, representing the second degree, has been figured on plate XXIII, fig. 7, where is a completely uncolored parenchyma-sheath with a thin-walled mestome-sheath inside this. The leptome and hadrome are not so strongly developed as in the preceding and they are not separated from each other by

thick-walled parenchyma. The stereome shows here but small groups and is often wanting on the inferior face, below the leptome. The uncolored parenchyma consists here of one or two cells on the hadrome side.

Concerning the distribution of these two forms of mestome-bundles it may only be said, that the smallest ones are prevalent in the whole blade. As indicated above, the stereome is rather weakly developed, and forms groups corresponding to the mestome-bundles. There are, however, besides these groups some isolated ones (plate XXIV, fig. 8) opposite the bulliform cells, and also above the middle of the lacunes on the superior face, besides one at each of the two margins of the blade. The mesophyll is strongest in the middle part of the blade, where it forms one large group on each side of the midrib; in the lateral parts of the blade it is interrupted by the large lacunes, which extend from the one mestome-bundle to the next one. The uncolored parenchyma is in the mature leaf restricted to small groups, corresponding to the mestome-bundles, as described above.

Pleuropogon Californicum (Nees.)—Plate XXIII, fig. 4, a transverse section of the middle part of the blade, shows a remarkable difference from the preceding species. There is a sharp carene on the superior face, a structure undoubtedly very rare in the Gramineæ. Otherwise the section reminds one very much of that of P. refractum.

The epidermis of the superior face consists of rectangular, thin-walled cells with slightly undulated side-walls, especially above the nerves. Wart-shaped expansions are numerous, although wanting above the large bulliform cells, and there are also some lines of thorn-shaped expansions in this species above the nerves. The stomates, which are equally distributed on both faces of the blade, are surrounded, not surmounted as in the preceding species, by warts. The epidermis of the inferior face differs in the presence of dwarf-cells in alternation with longer, rectangular ones, all showing distinctly undulated side-walls. Epidermal expansions are on this face merely warts, which form longitudinal lines below the stereome-bundles or sometimes also between these.

As to the mestome-bundles, these are also here, representing two degrees, of which the first one may be described from the median (plate XXIII, fig. 5). The parenchyma-sheath is uncolored and thin-walled, bordered above and below by one or

two similar uncolored cells. There is a distinct mestome-sheath, the walls of which are especially thickened inwards. The leptome and hadrome are separated from each other by two strata of thick-walled parenchymatic cells. These large bundles are supported by groups of stereome above and below, which are separated from the parenchyma-sheath by a few uncolored cells, excepting in the median one, where the mesophyll forms an uninterrupted group above the entire bundle. The mestome bundles of second degree differ in size from those of first degree; besides which the mestome-sheath shows merely thin-walled cells, and the leptome is in immediate contact with the hadrome.

The stereome agrees very well with that of P. refractum, but the number of isolated groups is larger here, there being three groups opposite the bulliform cells, one below and about three above the lacunes. The mesophyll and the uncolored parenchyma correspond in most details with those of the preceding species.

Pleuropogon Sabinei R. Brown.—Epidermis of the superior face consists of thin-walled, rectangular cells with nearly straight side walls, and there are numerous conical warts. The stomates are restricted to this face and are surmounted by conical expansions of the surrounding epidermis cells. The inferior face of the blade is entirely smooth; the cells show strongly undulated side-walls and are nearly equal in size.

A transverse section of half of the blade shows about the same structure as in P. Californicum with the sharp keel on the superior face. The mestome-bundles are also nearly the same, but it must be remarked, that in this species the mestome-sheath is merely thin-walled in both forms of bundles; besides which the leptome and hadrome are but imperfectly separated in the largest ones by a few not very thick-walled parenchymatic cells.

The stereome shows in this species a still smaller development than has been observed in the two other species, and forms here merely two isolated groups in the margins of the blade. The mesophyll and the uncolored parenchyma agree in all the details with the corresponding tissues of P. Californicum.

Considering now these three species of Pleuropogon together, it is evident that they are, in spite of their great sim-

ilarity, easily distinguished from each other by the following anatomical characters, taken from the leaf-blade:

Epidermis.

Thorn-shaped expansions on the superior face	P. refractum. / P. Californicum.
Epidermis of the inferior face perfectly smooth	P. Sabinei.
Epidermis of the inferior face with dwarf cells in alternation with long, rectangular ones	P. Californicum.
Stomates present on both faces	P. refractum. / P. Californicum.
Stomates present merely on the superior face	P. Sabinei.
Stomates surmounted with warts	P. refractum. / P. Sabinei.

Mestome-bundles.

Midrib forming a sharp carene on the superior face of the blade	P. Californicum. / P. Sabinei.
Mestome-sheath thick-walled in the largest bundles	P. refractum. / P. Californicum.
Leptome and hadrome separated in the largest bundles	P. refractum. / P. Californicum.
A few not very thick-walled cells between the leptome and hadrome of the largest bundles	P. Sabinei.

Mesophyll.

Forms two separate groups, one on each side of the midrib	P. refractum.

Stereome.

One isolated group opposite each of the two groups of bulliform cells	P. refractum.
Three isolated groups opposite each of the two groups of bulliform cells	P. Californicum.
One isolated group above each lacune	P. refractum.
One isolated group below and three above each lacune	P. Californicum.

Lacunes.

Bordering on the parenchyma-sheath of the mestome-bundles	P. refractum.
Separated from the parenchyma-sheath by a small layer of mesophyll	P. Californicum. / P. Sabinei.

U. S. National Museum, Washington, D. C.

EXPLANATION OF PLATES XXIII AND XXIV.

Figs. 1–3. *Distichlis maritima*.—Fig. 1. Transverse section of half of the leaf. The black part of the figure represents the mesophyll. × 75.—Fig. 2. Transverse section through the midrib. × 500.—Fig. 3. Transverse section through a small mestome-bundle. × 560.

Figs. 4, 5. *Pleuropogon Californicum*.—Fig. 4. Transverse section of the middle part of the blade. × 75.—Fig. 5. Transverse section through the midrib. × 560.

Figs. 6–9. *Pleuropogon refractum*.—Fig. 6. Transverse section through midrib. × 560.—Fig. 7. Transverse section through small mestome-bundle. × 560.—Fig. 8. Transverse section of the middle part of the blade. × 75.—Fig. 9. Epidermis of the superior face. × 210.

Figs. 10–12. *Pleuropogon Sabinei*.—Fig. 10. Transverse section of half of blade. × 75.—Fig. 11. Transverse section through midrib. × 500.—Fig. 12. Transverse section through a small bundle. × 560.

On the structure and dimorphism of Hypocrea tuberiformis.

GEO. F. ATKINSON.

(WITH PLATE XXV.)

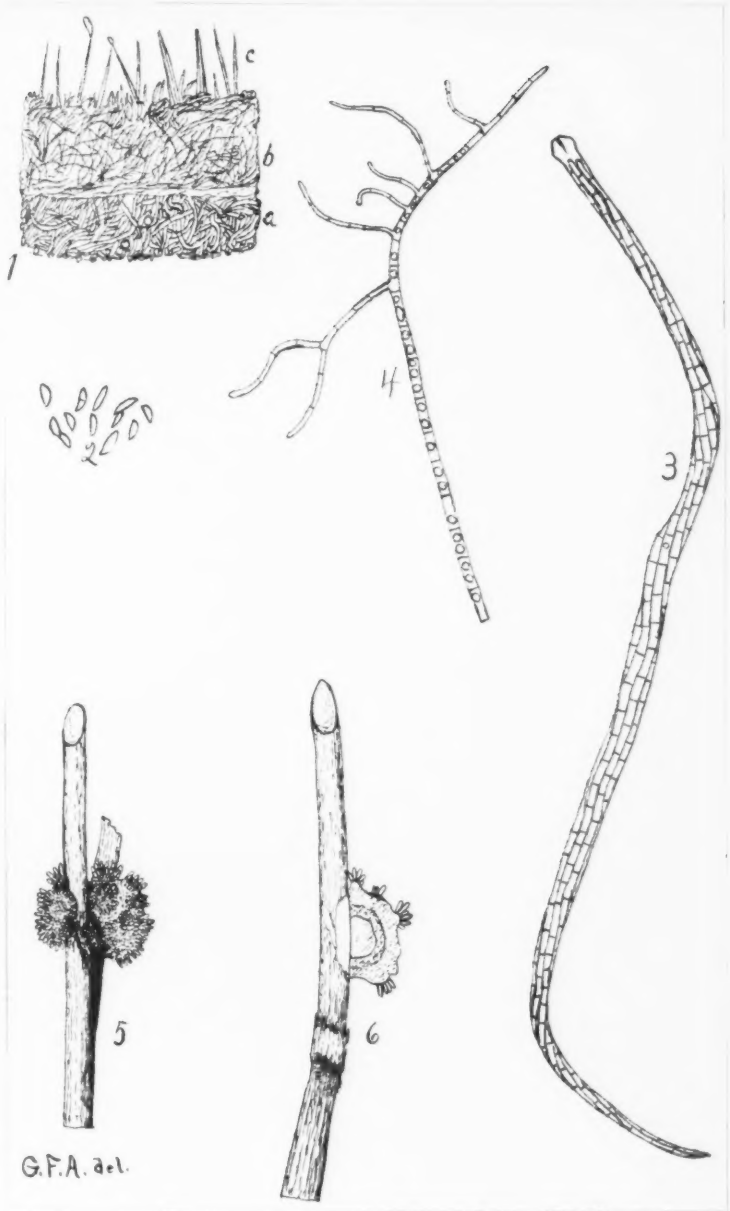
Hypocrea tuberiformis was described as follows by Berkeley in Grevillea IV, p. 13, from specimens collected by Ravenel in South Carolina: "Magna tuberiformis mycelio radiata albo affixa. On stems of *Arundinaria*. Car. Inf. Ravenel. No. 1220. Forming either a large mass $\frac{3}{4}$ of an inch across, or two or three distinct subglobose individuals, fixed to the stem by a radiating white rugose mycelium; at first yellowish, then black."

It was also distributed in Rav. F. Am. n. 733, and in Rav. Fung. Car. n. 52. Most of the specimens collected by Ravenel were probably sterile, since there is, to my knowledge, no published description of the forms of this dimorphic fungus.

Saccardo (Sylloge Fungorum II, p. 534) repeats Berkeley's description. Ellis and Everhart (Journal of Mycology II, p. 68) place it in the group of *Hypocreaceæ*, which constitutes Saccardo's genus *Hypocrella*, and add the following note, probably taken from specimens distributed by Ravenel: "Apparently the original specimens were imperfect and, as those in Rav. F. Am. are either young or sterile, we can only say that the perithecia are subcylindrical and stand on the stroma like the young horns of *Podisoma macropus*, about one millim. high."

Patouillard (Bull. de la Société Mycologique de France, VI, 2e fasc. pp. 107–9, 1890) describes a new genus of Hypocreaceæ under the name Dussiella. The perfect condition of the fungus he examined was deposited in the Berlin Museum and collected on stems of Arundinaria at Caracas, the conidial stage from specimens collected by Duss in Martinique. He considers these forms to be the conidial and ascosporous stages of *Hypocrea tuberiformis* B. & R., but unquestionably it is a very distinct fungus from the one described by Berkeley, from Ravenel's collection.

The perithecia are entirely immersed in the stroma, paraphyses are present, and while, as he states, the linear ascospores show its relationship to *Epichloe* and *Hypocrella*, the



ATKINSON on HYPOCREA.

peculiar structure of the apex of the asci in *Epichloe* and *Hypocrella* is not present in his specimens, or at least not represented in the illustration. I first collected sterile forms of *Hypocrea tuberiformis* B. & R. on Arundinaria at Columbia, S. C., during the winter of 1888–1889. During the last two years I have collected at Auburn, Ala., its sphacelia and ascigerous stages.

STROMA.—The stroma is subglobose, entire, lobed, or divided, seated upon the reed or upon the leaf sheath and fastened by a whitish mycelium, consisting of radiating, undulate threads, which sometimes become tinged with yellowish brown. It consists of two different strata when young, composed of slender, compactly interwoven hyphæ. The outer stratum is quite opaque, as shown in section, and yellowish. It is connected with the inner white stratum by loose threads. The whole is of a leathery or corky consistence. When mature a section shows three differently colored strata; an inner layer, white, which is sometimes tinged with pink; an intermediate layer, light ochre; and an outer layer, cinnamon. The intermediate layer is not quite so compact as the outer two. After the stroma is dead it sometimes becomes black.

SPHACELIA STAGE.—The sphacelia stage occurs at Auburn, Ala., in late spring. I first collected it May 10, 1890. The conidiphores radiate from the surface, which they thickly cover, and are needle-shaped, tapering gradually to a sharp point where the conidia are borne. They measure 35–40μ long by 2–3μ at the base. The conidia are oval or broadly fusoid, inequilateral, hyaline, mostly continuous, but the larger ones sometimes faintly one-septate. Size, 3.5–4 × 7–10μ.

ASCIGEROUS STAGE.[1]—The perithecia are sessile, or only the rounded base immersed in the superficial part of the stroma. They are subcylindrical, a little broader in the middle than at each end, floccose, with loose white threads through which the cinnamon color shows. The apex is smooth and resembles the apex of *Epichloe typhina* (Pers.) Tul. The ostiolum is distinct. They are about 1 millimeter long by one-third of a millimeter in diameter, and stand on the stroma singly or in groups of 3–4–20, or crowded over a large portion. They are frequently branched, the bases of two, three or more being joined and the cavities confluent below.

[1] Mature in August and September.

The asci are 8-spored, very large, varying from 450–750 × 14μ, tapering to a slender point at base, more gradually toward the truncated apex. They are very stout at the apex, somewhat like those of *Epichloe typhina* (Pers.) Tul. and *Hypocrella atramentosa* (B. & C.) the end being slightly enlarged, conoid and truncate.

The ascospores are linear, hyaline, pluriguttulate and pluriseptate, rounded at each end, at maturity separating at the septa and frequently germinating while yet within the perithecia, the germ tubes arising from any of the segments, sometimes before the sporidia separate at the septa. In most of the asci there is indication of a narrow slit through the apex, represented by a dark line, but I have never seen the spores escape through it. I have observed the same thing in the asci of *Epichloe typhina* (Pers.) Tul., but have not been able to determine positively whether it is a slit or only an opaque line.

We are able to see from this study the affinity of *Hypocrea tuberiformis*, B. & R., with Epichloe, since its only disagreement lies in the fact that the stroma of Epichloe, as characterized, entirely surrounds the stem of its host, while those agreeing in all essential parts of structure, but only partially surrounding their hosts, are provided for in Saccardo's genus Hypocrella. It thus frequently transpires that the genetic relationship of some forms is determined by fortuitous circumstances rather than by structural affinity.

Hypocrea atramentosa B. & C. might have been an *Epichloe* were it not for the fact that it appears too early in the season upon the opening buds of *Andropogon Virginicus*. These it first entirely embraces with its infant stroma, when later Andropogon rises, tears it asunder, bears it only upon the underside of the leaves in the cluster, and leaves it nothing but a Hypocrella! But, until a monographic study can be made of members of both genera, *Hypocrea tuberiformis*, B. & R. should read, *Hypocrella tuberiformis* (B. & R.) My specimens were collected on *Arundinaria macrosperma* Michx. var. *suffruticosa* Munro (*Arundinaria tecta* Muhl.)

I take this opportunity of noting the favor extended by Mr. B. T. Galloway, Chief of the Division of Vegetable Pathology, Washington, D. C., in allowing me the use of the Bull. de la Soc. Myc. de France, *tom. cit.* and Ravenel's two exsiccati,

Fung. Am. and Fung. Car. I find that n. 52 of the latter is a perfect condition of this fungus.

Department of Biology, Alabama Polytechnic Institute, Auburn, Ala.,

EXPLANATION OF PLATE XXV.—*Hypocrella tuberiformis* (B. and R.) Atkinson. Fig. 1, section of portion of young stroma; *a* inner layer; *b* outer layer; *c* conidiophores. Fig. 2, conidia. Fig. 3, ascus with linear ascospores. Fig. 4, portion of ascospore germinating. Fig. 5, perfect condition, stroma bearing perithecia. Fig. 6, section of stroma. Figures 5 and 6 are magnified about 1½ times, the other figures much more.

Notes on the Flora of Canada.

JAMES M. MACOUN.

During the season of 1890 a considerable number of plants were discovered in various parts of Canada that were either new to the Dominion or were of sufficiently rare occurrence to be worthy of note. Except when otherwise mentioned all the plants in this list were collected by Prof. Macoun and myself in British Columbia. The asterisk (*) after the name of a plant signifies that it had not before been found in Canada.

1. Thalictrum Fendleri ENGELM.*—Very abundant in low grounds at Kicking Horse Lake, Rocky Mts.

2. Ranunculus hispidus MX. var. Oreganus GRAY.*—Low grounds at Sproat, on the Columbia River, 15 miles north of the International Boundary, and on the Kootenay river, about half way between Sproat and Kootenay lake, B. C.

3. Ranunculus hederaceus L.*—Marshes near New Harbour, Newfoundland. Collected by Rev. A. C. Waghorne in 1889 and 1890.

4. Isopyrum biternatum TORR. & GR.*—Abundant in the vicinity of London, Ontario. Collected by J. Dearness.

5. Delphinium simplex DOUGL.—Very abundant on rocky banks, about 2 miles above the junction of the Kootenay and Columbia rivers, B. C.

6. Papaver nudicaule L. var. arcticum, ELKAN.—One clump of about twenty specimens was found on the mountains at Kicking Horse Lake, Rocky Mts., at an elevation of 8,000 feet.

7. Cardamine bellidifolia L.— Three specimens of this minute species were found growing with *Draba alpina* in mud on the western slope of Avalanche Mt., Selkirk Mts., B. C., altitude 7,500 feet. Not collected in Canada since Drummond's time.

8. Arabis Macounii WATS. — A new Arabis that has been named as above by Dr. Watson, and has lately been described, grows in abundance on gravelly slopes, west of the Columbia River at Revelstoke, B. C.

9. Draba nivalis JACQ. var. elongata WATS. — A few specimens of this plant were collected on the mountains at Kicking Horse Lake last season, where it had been found in 1885, but not separated from *Draba stellata* Jacq., with which it was growing.

10. Thysanocarpus pusillus HOOK. — Gravelly slopes at Sproat, B. C. Not recorded from interior before.

11. Silene Macounii WATS. — Dr. Watson has recently separated this species from S. multicaulis, and all Rocky Mountain references in Macoun's Cat. of Can. Plants belong to this species. Not rare on the mountains at Rogers' Pass and Kicking Horse Lake.

12. Arenaria tenella NUTT. — On dry ground at Kamloops, B. C. Not collected before in interior.

13. Stellaria longipes GOLDIE, var. Edwardsii T. & G.— Not rare on mountains at Kicking Horse Lake, Rocky Mts. Not recorded before from western Canada.

14. Sidalcea malvæflora GRAY. — Common at Revelstoke, B. C. Not recorded before from interior.

15 Claytonia cordifolia WATS.*— Abundant in woods (5,000 feet alt.) at "Warm Springs," Kootenay Lake, B. C.

16. Trifolium involucratum WILLD. — Revelstoke, B. C. Not found in interior before.

17. Trifolium microcephalum PURSH. — Revelstoke and Sproat, B. C. Not found in interior before.

18. Fragaria Virginiana DUCH. var. Illinoensis GRAY.— The common form at Deer Park, Lower Arrow Lake and Toad Mt., B. C.

19. Epilobium clavatum TREL. — A few specimens were found on mountains at Kicking Horse Lake, at an altitude of 7,000 feet.

20. Peucedanum bicolor WATS.*— Hillsides at Sproat, B. C.

21. Zizia cordata KOCH.—Rare at Kicking Horse Lake, Rocky Mts. The western limit in Canada.

22. Ligusticum scopulorum GRAY.*—Specimens collected at Rogers' Pass, B. C., have been doubtfully referred here by Prof. Coulter.

23. Angelica Lyallii WATS.*—In subalpine woods at Sproat, B. C.

24. Cornus pubescens NUTT. var. Californica, C. & E.*—Common at Sproat and Revelstoke, B. C.

25. Aplopappus Lyallii GRAY.*—With A. Brandegei on mountains at Kicking Horse Lake, altitude 8,000 feet.

26. Aster stenomeres GRAY.*—Amongst rocks on mountains at Sproat, B. C.

27. Antennaria luzuloides T. & G.—Deer Park, Lower Arrow Lake. Rare in Canada.

28. Gnaphalium decurrens SPRENG. var. Californicum GRAY.*—Rare at Revelstoke, B. C.

29. Hemizonella Durandi GRAY.*—On hillsides at Sproat, B. C.

30. Madia glomerata HOOK.—Revelstoke, B. C. Western limit in Canada.

31. Madia sativa MOL. var. racemosa GRAY.*—Near Sproat, B. C. Eastern limit in Canada.

32. Arnica Parryi GRAY.*—Mountain slopes at Kicking Horse Lake, Rocky Mts.

33. Arnica latifolia var. viscidula GRAY.*—Wooded slopes at Rogers' Pass, Selkirk Mts., B. C.

34. Arnica cordifolia var. eradiata GRAY.*—Woods at Deer Park, Lower Arrow Lake, B. C.

35. Microseris nutans GRAY.*—Common at Sproat, B. C.

36. Crepis runcinata T. & G.—Revelstoke, B. C. Western limit.

37. Heterocodon rariflorum NUTT.—Sproat, B. C. Eastern limit.

38. Micromeria Douglasii BENTH.—"Hot Springs," Kootenay Lake, B. C. Northern and Eastern limit in Canada.

39. Eriogonum niveum DOUGL.*—Lake Okanagon, B. C. Collected by J. McEvoy.

40. Asarum caudatum LINDL.—Revelstoke, B. C. Eastern limit in Canada.

41. Epipactis Helleborine CRANTZ.*—Near Lambton Mills, Ont. Collected by W. and O. White.

42. Epipactis gigantea DOUGL.—Deer Park, Lower Arrow Lake and "Hot Springs," Kootenay Lake, B. C. Rare in Canada.

43. Allium Nevii WATS.—Lytton, B. C. Collected by Jas. McEvoy. Only found before in Canada on Vancouver Island.

44. Potamogeton crispus L.*—Ashbridge's Bay, east of Toronto, Ont. Collected by Wm. Scott.

45. Carex Tolmiei BOOTT, var. nigella BAILEY.*—Mts. at Kicking Horse Lake, Rocky Mts.

46. Carex marcida BOOTT, var. debilis BAILEY.*—Kicking Horse Lake, Rocky Mts.

47. Agrostis geminata, TRIN.*—Rogers' Pass, Selkirk Mts.

48. Agrostis alpina.*—Rogers' Pass, Selkirk Mts., B. C.

49. Alopecurus geniculatus L. var. robustus VASEY, (n. var.) Kicking Horse Lake, Rocky Mts.

50. Deyeuxia glomerata VASEY, (n. sp.)—Kicking Horse Lake, Rocky Mts.

51. Deyeuxia Canadensis HOOK. var. occidentalis VASEY.* Kicking Horse Lake, Rocky Mts.

Ottawa, Canada.

What the station botanists are doing.

BYRON D. HALSTED.

The present season is one of unusual activity among station botanists. At the risk of repetition I record briefly the leading points obtained by the several workers and in the alphabetical order of their names:

ALWOOD, of Virginia, has demonstrated an effective treatment for a leaf blight of the apple and established the fact that weak Bordeaux preparations are as effective for grape rot as stronger ones. He has been successful in the artificial pollination of wheat.

ARTHUR, of Indiana, has shown that the water for killing smut spores in soaking wheat can be heated to a considerably higher temperature than heretofore thought safe, and that this treatment, while effective in destroying the smut spores, much increases the yield of the grain. He has shown that the copper sulphate method is effective with oats but detrimental to

the yield, and that the hot water method is equally effective. Results in the method of preparing seed potatoes have been obtained that may materially modify the customary ways of planting.

ATKINSON, of Alabama, has considered the fungous diseases of the cotton, describing some new species and recommending methods of treatment. He finds *Colletotrichum gossypii* South. on leaves and stems of cotton as well as the bolls; notes great injury to the fig by *Uredo Fici*, with suggestions as to spraying the tree to prevent it, and records for the first time in the United States the *Cercospora Bolleana* on leaves of the fig. He describes the nature of "Frenching" in cotton and shows that it is due to a fungus—a species of *Fusarium*. Critical notes have been published upon Erysipheæ of the Carolinas and Alabama, including the new species, *Microsphæra caloclad-ophora* on *Quercus aquatica*.

BEAL, of Michigan, continues his experiments on grasses and clovers, that were planned several years ago.

BESSEY, of Nebraska, has investigated the natural forestry of the state and will soon publish the results. He is continuing his study of the forage problem of the plains.

BURRILL, of Illinois, has determined practical methods of exterminating Canada thistles. These pests do not seed in the rich prairie soil, but spread by rootstocks. Excellent results have been obtained with copper compounds as fungicides for grape rot, apple scab and potato blight. The latter is demonstrated to be a bacterial disease. A serious trouble of the blackberry and raspberry he has traced to the twig blight of pears (*Micrococcus amylovorus*). Studies are in progress upon several other bacterial diseases. *Puccinia rubigovera* has been found living over winter in the leaves of wheat and producing rust spores in early spring which grow upon the fresh foliage.

CHESTER, of Delaware, while confining himself almost exclusively to treatment of fungous diseases, has, in connection with the chemist, reached important conclusions as to the preparation of fungicides; e. g., in the use of carbonate of ammonia instead of aqua ammonia; the employment of glue and the use of a double hyposulphate of copper. It is now too early to report upon many field experiments. A study has been made of leaf spot of alfalfa, wheat scab, and rot of scarlet clover.

CRANDALL, of Colorado, is making a flora of the state, paying particular attention to the native grasses and fruits, and diseases of cultivated crops.

DETMERS, of Ohio, is studying the life history of the blackberry and raspberry, apple scab and potato blight, and the value of various fungicides. A state herbarium is being made.

DUDLEY, of New York, has found that the clover rust, prevalent from New England to the Sierras, is chiefly propagated in the uredo form, and is carried over the winter as mycelium. It was demonstrated that the æcidiospores produce uredo spots, and therefore the *Æcidium Trifolium-repentis* and *Uromyces Trifolii* are stages of the same species. The rust spores germinate best at a low temperature. As the second crop is most frequently infested, and as this is a valuable fertilizer, it often may be well to plow it under. The ordinary spores of the quince blight (*Entomosporium maculatum*) winter on the fallen leaves, not on the tree, so that germinating in early spring they infect the host directly. Therefore all leaves should be burned in autumn.

GARMAN, of Kentucky, shows that Bordeaux mixture and eau celeste will check the strawberry blight. Salt and lime may be used to prevent the growth of the broom rape, but will injure the host plant. Blue stone is satisfactory except its expensiveness. Hot water may be used to kill the broom rape seed, while doing no injury to, but rather benefiting, the hemp seed. Broom rape seed will retain its vitality in the soil for at least ten years. Anthracnose of the grape can be controlled by using blue stone 6½ lbs., lime 3½ lbs. to 22 gallons of water.

HALSTED, of New Jersey, is studying sweet potato and egg-plant diseases in particular, and looking after weeds in a general way.

HARVEY, of Maine, in his tests for germination of seeds, finds that a solution of corrosive sublimate of a proper strength to destroy the germs of mould, will injure the vitality of the treated seed. Fungicides and weeds are receiving attention.

HUMPHREY, of Massachusetts, has found the true pycnidial form of the black knot fungus, identified the "damping off" fungus with that causing the same trouble in Europe, added new facts concerning the scab of potatoes, the Peronosporeæ of the cucumber and the hibernation of cherry rot.

JONES (L. R.), of Vermont, during this his first year, is ex-

perimenting with fungicides upon potato rot, apple scab and rust, and oat and corn smut, but it is too soon for a report of results.

KELLERMAN, of Kansas, is moving to Ohio, but his work upon smuts and breeding of corn will remain as fine examples of his many important investigations beyond the Missouri.

LAMSON, of New Hampshire, writes that his work in the station for the year consists in collecting grasses, weeds and weed seeds, and of beginning in mycology and bacteriology.

MCCARTHY, of North Carolina, besides preparing a hundred page bulletin upon best agricultural grasses, has given much attention to field experiments with fungicides. The Burgundy mixture with soap is superior to the Bordeaux and the latter is improved by adding a small amount of glue. Seed testing is continued in co-operation with other stations.

MILL, of Alabama, has made a microscopic study of the cotton plant and is endeavoring to improve its fiber and seed by crossing. The effect upon lumber of tapping for rosin is being investigated. Wild grasses for grazing purposes and weeds are receiving attention.

SCRIBNER, of Tennessee, has a report ready for the press upon the grasses of the state. The work upon fungous diseases is being continued.

TRACY, of Mississippi, is engaged upon a flora of the state, is deeply interested in grasses and the blight of the tomato.

THAXTER, of Connecticut, it is with regret I note, has retired from distinctively station work, after doing excellent service in economic mycology. The results of his study of the onion smut, potato scab, apple rust and other fungous enemies, and means of controlling them, will be of permanent value. Dr. Sturgis succeeds him at New Haven.

BUCKHOUT, of Pennsylvania, and some others have a full load of college work.

BOLLEY, of North Dakota, and WOONTON, of New Mexico, are busy in their new fields.

New Brunswick, N. J.

BRIEFER ARTICLES.

A neglected Spartina.— During the past two or three years I have received from Florida, Mississippi and Texas, specimens of a Spartina which I was at first disposed to consider new, but which I now think is *S. juncifórmis* ENGELM. & GRAY, described in the *Boston Journal of Natural History* v. (1845) p. 238. It is evidently the S. gracilis of Chapman's Flora, but not at all the true *S. gracilis* TRIN. (not Hooker), which is well described by Mr. Watson in the Botany of the Fortieth Parallel as having "4 to 10 spikes, mostly sessile and appressed to the rachis, with the glumes and lower palet (floral glume) ciliate-hispid on the keel." It is a species of the Rocky Mountain region and the Pacific coast. The S. juncifórmis seems to be confined to the Gulf region, and may be described as follows:

Culms stout, smooth, 3 to 4 feet high; leaves involute, those of the radical tufts 1 to 2 feet long, those of the culm 5 or 6, generally involute, rigid, narrow, smooth, the lower 1 foot long, the upper shorter; ligule a very short hairy fringe, lower sheaths mostly shorter than the internodes, the upper longer; panicle spike-like, 5 to 10 inches long, dense, often cylindrical, tapering at the apex, composed of 30 to 50 or more sessile, imbricated, appressed spikes or branches, which are from ½ inch to 1 inch long at the apex, the lower ones longer and less dense; spikelets 2½ to a little over 3 lines long, the upper empty glume a little longer than the floral glume, the lower one ¼ or ⅓ shorter, both hispid on the keel, both very shortly mucronate, or sometimes without the mucro; floral glume slightly hispid on the back, obtuse; palet smooth about equaling its glume.

Florida, *J. H. Simpson;* Mississippi, *Prof. S. M. Tracy;* Texas, *G. C. Nealley*. Probably confined to the vicinity of the Gulf of Mexico.

Prof. Scribner, to whom I sent specimens of this Spartina, states that the same was collected last year by Mr. Pringle in Mexico, and that he identified it as *S. densiflóra* BRONG. which is a native of Chili. He also states that *S. Gouini* FOURN., Mex. Pl. Enum. Gram. p. 135, is apparently the same. It may be doubted whether the Chilian species is the same as our plant; perhaps only an inspection of specimens will enable us to determine; but if Fournier's plant is the same, his name must give place to that of Engelmann and Gray, as that was published many years earlier.— GEO. VASEY, *Dep't of Agriculture, Washington, D. C.*

EDITORIAL.

THE GENERAL ignorance regarding the essential processes of plant life is appalling. If one were to ask the persons he met in a walk what trees lived on and how they secured their food, the answers received would doubtless be more curious than edifying. It would probably be a safe venture to assert that not one college graduate in one hundred can give a clear statement of vegetable nutrition, assimilation and respiration. And yet the college graduate has doubtless had the best opportunity of any class of persons to become informed upon subjects like these. The fact is that some of the most generally interesting topics relating to plants, those which bring plants into a more intimate relation with animals as living, active beings, have not yet received due recognition from general educators, or even from botanical teachers themselves. No one can accuse American botanists of being slow or of lack of enthusiasm, but having been absorbed in assorting the rich material of the native flora, in working out the life histories of the lower forms, and in studying minute structures by the newly developed staining and embedding methods, there has seemed to be no room and time for the consideration of other topics. But no one who has watched the course of the science elsewhere, or even at home, can doubt that the day for physiology to be the dominant subject in American botanical thought is not far off. When that day arrives, we may expect it to be more absorbing and more revolutionary of previous ways of thinking, than any of the recent waves that have disturbed the even tenor of botanical progress. It is to be hoped, indeed, that, besides the changes which may be effected in the course of thought within the botanical domain, this wave may be sufficiently powerful to beat high upon the rock bound coast of popular ignorance. Such a change in sentiment might give the opportunity to establish a new set of ideas regarding matters of physiology.

CURRENT LITERATURE.

Recent Systematic Papers.

CONTRIBUTIONS FROM THE NATIONAL HERBARIUM.—The first volume of this series of contributions is continued by the appearance of no. 4, issued June 30, 1891. It is the work of Mr. J. N. Rose, Assistant Botanist, and treats of the collections of plants made by Dr. Edward Palmer, in 1890, in western Mexico and Arizona. The collection from Alamos and vicinity proved to be a very rich one, no less than 45 new

species being described in the paper. Ten of them are illustrated by full page or large folded plates. A new genus of Leguminosæ, *Willardia*, is proposed for a species that Dr. Watson referred doubtfully to Coursetia, as C. Mexicana. To give any notion of the nearly half a hundred new species is impossible in this brief review. The contribution, however, is creditable to the Division, and the chief Botanist deserves congratulation for the organization and promotion of this kind of work. There are some blemishes in matters of detail and a few marked inconsistencies between drawings and descriptions.

Watson's Contributions.— Dr. Sereno Watson's "Contributions to American Botany, XVIII" is before us, appearing in Proceedings of American Academy, XXVI, 124–163. Part 1 contains the description of eight new species, chiefly from the United States, and a revision of the American species of Erythronium. Thirteen species of Erythronium are recognized, but one of which is new, although *E. mesochoreum* Knerr may be considered as such. Part 2 contains the descriptions of new Mexican species from the Pringle collections of 1889 and 1890. Among the 88 new species there described, two new genera appear, viz.: *Neopringlea*, to replace the preoccupied Llavea, a genus usually placed with the Celastraceæ, but whose affinities are shown to be in the Sapindaceæ; and *Oligonema* (now *Golionema*), a genus of homochromous Asteroideæ. Part 3 is concerned with a wild species of Zea from Mexico, described under the name *Z. canina*. At first thought to be the original wild state of our cultivated maize, Dr. Watson now considers it a distinct species. Part 4 contains some notes upon a collection of plants from the Island of Ascension, including three new species, a Rubus, an Asplenium, and a Nephrodium.

Supplementing the above is Mr. B. L. Robinson's "Contribution from the Gray Herbarium," in the same volume of Proceedings of the American Academy, pp. 164–176. It contains descriptions of new plants from the Pringle collections of 1889 and 1890, twenty-six species, chiefly Gamopetalæ, being established.

Prof. F. Lamson-Scribner has just issued a paper (Proceedings of Philadelphia Academy, 1891, 292–309) treating of the Mexican grasses collected by Pringle in 1890, and also by an expedition in the same year from the Philadelphia Academy. Pringle's grasses number thirty-six species, three of which (Muhlenbergia) are new, although a good deal of synonymy is corrected. The paper contains a full page plate and two cuts in the text.

Mr. Thos. Morong has published notes on the North American Halorageæ which appear as a reprint from the *Bulletin of the Torrey Botanical Club*, 18, 229–246. Hippuris is made to contain three species.

Callitriche is credited with eleven, one of which, C. longipedunculata, is a new species from S. California. Proserpinaca includes two species; while Myriophyllum contains twelve. In the last genus M. ambiguum, var. limosum Nutt. becomes M. humile (Raf.), and M. scabratum Michx. becomes M. pinnatum (Walt.)

MR. A. P. MORGAN has issued the fourth paper in his series on North American Fungi, being a reprint from the *Journal of the Cincinnati Society of Natural History*, April, 1891. It treats of the genus Lycoperdon, which is made to contain thirty-one species, two of which are new. The paper is illustrated by two plates.

Minor Notices.

MR. J. S. CHAMBERLAIN has been making a comparative study of the styles of Compositæ. His paper containing 22 pp. and four plates, is issued as a reprint from the *Bulletin of the Torrey Botanical Club*, xviii, 175. Mr. Chamberlain concludes that while style characters are very useful in the classification of tribes, they cannot be relied upon entirely.

AN ENLARGED and greatly improved edition of Woolls' "Plants indigenous and naturalized in the neighborhood of Sydney" has just been issued. The plants are arranged according to the system of Baron F. von Mueller. The species of vascular plants number 1465, of which 175 are naturalized.

A VERY VALUABLE contribution to the literature of Geographical Botany is the paper just published by Mr. Warren Upham in *Proceedings of the Boston Society of Natural History*, 25, 140–172, entitled, "Geographic limits of species of plants in the basin of the Red River of the North." Mr. Upham's extensive investigations into the glaciology of that region, combined with his botanical training, have well fitted him to discuss the relation of plant distribution and migration to climate.

THE ANNUAL REPORT of the Geological Survey of Arkansas for 1888 has just appeared. Half of the report is devoted to a list of the plants of Arkansas, together with some general discussion of the state flora, by John C. Branner and F. V. Coville. The list does not pretend to speak of geographical distribution, but any fairly complete list of plants from Arkansas is of interest.

PROF. CONWAY MACMILLAN has distributed a reprint of his article in the *Revue général de Botanique*, on the European plants which have been introduced into the valley of Minnesota.

OPEN LETTERS.

Where is the home of Calypso?

I was much interested in Mr. Blanchard's notes on this dainty plant in the August number of this paper, for every botanist loves Calypso. If abundance of individuals is to determine the true home of the Calypso, then the Puget Sound region will easily bear the palm from northern Vermont. Fifty or one hundred specimens in half a day does not not seem at all impressive to me, for I have frequently gathered bouquets of several hundred in a few hours; and only two years ago I saw a boy selling bunches of 100 or more for ten cents, a fact which speaks more for the abundance of the plant than for proper local appreciation of its beauty. What is particularly interesting is that the habit of Calypso here seems to differ very decidedly from its habit in the east. The plant here never grows in Sphagnum bogs; indeed from my experience with it, I would nearly as soon look for it on exposed rock as in Sphagnum. I find it in rather dry and open coniferous woods, especially where the ground is covered with Hypnum Oreganum. It seems to have a decided preference for this moss and an almost equal antipathy to Hypnum splendens.

It would perhaps be better for Calypso did it grow here in Sphagnum, for its home in dry Hypnums renders it peculiarly subject to destruction by forest fires. I know of many places where a few years ago it was abundant, that will never again be brightened by its dainty slippers, all owing to fires. So I shall not be surprised if in a very few years the plant will be found more abundant in Vermont than it will be here.

I find that a large proportion of the plants here are fertile. The only insects I have seen on the flowers were ants, which were feeding on the nectar. I am inclined to believe that they are not the usual, if indeed at all, the fertilizers of Calypso.—CHAS. V. PIPER, *Seattle, Wash.*

Botanical Clubs in California.

A paragraph in the July GAZETTE mentions the organization of a botanical club in San Francisco. The beginning of this year witnessed the formation of two, one in Berkeley and one in San Francisco. The former dates from February 25, and is named the Chamisso Botanical Club, in memory of the distinguished botanist who visited the California shores in the early part of the century. It grew out of a purely spontaneous desire on the part of a number of post- and undergraduate students to engage in some work that would contribute to the knowledge of the California flora, and to this end they perfected an organization in which the professor of botany was in no way concerned and of which he was entirely ignorant until after the young society was fairly on its feet, and had mapped out for itself a special line of work. The members have been engaged in the accumulation of material for an annotated list of the plants growing within twenty miles of San Francisco, and have discovered many species new to the region and expect to "undiscover" a few that have been credited to this locality and do not grow here.

The other is the California Botanical Club, organized in San Francisco March 5, much more pretentious in point of membership, its roll bearing at last accounts one hundred and twenty-five names. On the list are the names of some well-known botanists of the Pacific Coast; but the majority are ladies who are interested in ferns and flowers. The club has a field of usefulness, in teaching and interesting in botany those who have leisure, and thus enlisting a larger number in the work of collecting and exploration — a work which is, in this state, only well begun.— WILLIS L. JEPSON, *Berkeley, Cal.*

NOTES AND NEWS.

PROFESSOR DR. GOEBEL has accepted a call to the University of Munich as Professor of Botany and Director of the Botanic Garden.

MR. ARTHUR LISTER, in *Journal of Botany* (Sept.), has published some notes on Mycetozoa, accompanied by four plates. The paper is a notice of the species not included in Dr. Cooke's "Myxomycetes of Great Britain," and contains the description of three new species.

THE HERBARIUM of the late Dr. C. C. Parry has now been arranged for sale, together with an extensive library of botanical works. A catalogue has been issued, which shows 6,780 species, represented by about 18,000 specimens. Of these 5,290 species are North American. Full information can be obtained from Mrs. E. R. Parry, Davenport, Iowa.

IN ANSWER to a request from the city council of Cleveland, Ohio, the U. S. Department of Agriculture detailed Prof. J. C. Arthur, as an agent of the Forestry Division, to examine into the causes of the injury and death of the shade trees of that city. His report ascribes the injury to the excessive quantities of coal smoke, more particularly to the noxious gases which accompany the smoke.

SPHÆROTHECA LANESTRIS Hark. has been supposed to be confined to California, and to a single host, *Quercus agrifolia*, but both the conidial and the mature forms have been found this season in Mississippi, by S. M. Tracy. It occurs on *Quercus prinus*, *alba*, *macrocarpa* and *falcata*, and is rather abundant. The conidial form has also been found in Alabama on Q. alba, by Mr. Geo. E. Atkinson.

FR. JOHOW, who has given much attention to phanerogamous parasites, proposes the following grouping for them, based upon habit: 1. euphytoid parasites, erect land plants, including five families with 35 genera and 400 species; 2. lianoid parasites, including the genus Cuscuta with 77 species and Cassytha with about 20; 3. epiphytoid parasites, tree-dwellers, including 500 Loranthaceæ and 15–18 antarctic Santalaceæ; 4. fungoid parasites, including about 60 species of the two families Balanophoreæ and Cytinaceæ.

AT A MEETING of the Royal Society of Canada, held May 29th last, a club was formed by the botanists present, to be known as the Botanical Club of Canada. It has no connection with the Royal Society other than that which all scientific and literary societies enjoy.

The object is to adopt means, by concerted local efforts and otherwise, to promote the exploration of the flora of every portion of British America, to publish complete lists of the same in local papers as the work goes on, and to have these lists collected and carefully examined in order to arrive at the correct knowledge of the precise character of the flora and its geographical distribution.

The method is to stimulate, with the least possible paraphernalia of constitution or rules, increased activity in the botanists in each locality, to create a corps of collecting botanists wherever there may be few or none at present, to encourage the formation of field clubs, to publish lists of local floras in the local press, etc., etc. Any person interested in the study of botany is eligible.

The general officers for the year are: Dr. George Lawson, of Halifax, president; A. H. MacKay, of Halifax, secretary and treasurer. There is also a secretary for each province, who will, in turn, appoint local secretaries in such localities as he may deem expedient. It is the duty of the local secretaries to stimulate botanical research in their districts, and to endeavor to secure such notes on occurrence and situation of specimens, as may eventually enable the club to publish a special catalogue of the flora of the region. We wish the new club success.

M. GUSTAVE CHAUVEAUD has investigated in great detail the non-articulated laticiferous tissue and the account of his study forms parts 1 and 2 of the *Annales des Sciences Naturelles*, Botanique, 7, xiv, pp. 160, 8 plates. The subject has long needed investigation. We translate his conclusions:

The continuous primitive laticiferous apparatus is formed by special initial cells which are the first elements of the embryo differentiated. These initial cells, rarely four, sometimes eight, frequently more numerous, are of constant number in each species. They appear always in the same transverse plane (the nodal plane), and are formed in most cases at the expense of the pericycle. They elongate into tubes and become much branched, constituting in the embryo a complex system often of great regularity. Later this system increases and furnishes the laticiferous system of the seedling and the adult plant. In case the plant acquires secondary formations, these formations are traversed by laticiferous tubes springing from the branches of the primitive laticiferous system near the generating layers. The appearance of new initial cells has not been observed after the first stages of embryonic development. The tubes do not show anastomoses nor transverse partitions. The branches in certain species are distributed through the pith as well as through the bark. Their terminations are not localized in a special tissue; they are found in the leaves and cotyledons either in the midst of the parenchyma or underneath the palisade cells or even more frequently in contact with the epidermis. In certain plants the continuous tubes seem to precede the appearance of the articulated tubes. Finally, they are not met with except in the Euphorbiaceæ, Urticaceæ, Apocynaceæ and Asclepiadaceæ, where they serve to characterize certain tribes.

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